Citation:

Engberink MF, Geleijnse JM, de Jong N, Smit HA, Kok FJ, Verschuren WM. Dairy intake, blood pressure, and incident hypertension in a general Dutch population. *J Nutr*. 2009 Mar;139(3):582-7.

PubMed ID: 19158223

Study Design:

Prospective Cohort Study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To investigate whether dairy consumption, including specific dairy food groups, was associated with blood pressure and risk of hypertension in a Dutch population-based cohort of 21,553 participants aged 20–65 ywho did not use antihypertensive medication.

Inclusion Criteria:

- Data from the Monitoring Project on Risk Factors for Chronic Diseases.
- Men and women aged 20–65 y who did not use antihypertensive medication.

Exclusion Criteria:

- Participants with missing dietary or BP data.
- Participants who used antihypertensive medication.

Description of Study Protocol:

Recruitment

- Data from the Monitoring Project on Risk Factors for Chronic Diseases, a population-based study of 23,105 men and women aged 20–65 y who were examined between 1993–1997 from 3 Dutch towns (Amsterdam, Doetinchem, and Maastricht).

Design: Prospective cohort study

- Participants from Doetinchem (n = 6579) were invited for follow-up examination (including BP) in 1998–2002 and 75% (n=4917).
- Dietary intake was assessed using a validated, semi-quantitative FFQ.
- The validity of the FFQ was assessed against 12 monthly 24-h recalls over a 1-y period. Total dairy included all dairy foods except butter and ice cream.
- Milk and milk products included all kinds of milk, yogurt, coffee creamers, curd, pudding, porridge, custard, and whipping cream.

- Cheese included all types of cheese, as well as cheese spreads and cheese that was consumed during dinner or as a snack.
- Low-fat dairy was defined as milk and milk products with a fat concentration <2.0 g/100 g or cheese with a fat concentration <2.0 g/100 g.
- High-fat dairy was defined as milk and milk products with a fat concentration >3.5 g/100 g or cheese products with a fat concentration >2.0 g/100 g.
- Fermented dairy comprised buttermilk, yogurts, and cheese.

Blinding used (if applicable): not applicable

Intervention (if applicable): not applicable

Statistical Analysis

- Data analysis was performed using SAS version 9.1 (SAS Institute).
- Logistic regression models were used to obtain odds ratios (OR) with 95% CI for incident hypertension in categories of dairy intake, with adjustment for age and sex (model 1).
- Analyses were repeated using an extended multivariate model (model 2) that included age, sex, total energy intake (continuous), BMI (continuous), current cigarette smoking (yes/no), socioeconomic status (5 categories), and alcohol consumption (0, 0–1, 1–2, 2–4, 4–8, .8 glasses/d).
- Further adjustment was made for intake of fruit, vegetables, fish, meat, bread, coffee, and tea, all as continuous variables (model 3).
- To obtain a P-value for trend across categories of dairy intake, median values of categories were assigned to individuals and entered continuously into the multivariate models. Two-sided P-values <0.05 were considered significant.

Data Collection Summary:

Timing of Measurements

Dairy consumption assessed at baseline in 1993–1997. Follow-up examination (including BP) in 1998–2002.

Dependent Variables

- Blood pressure
- Incident hypertension

Independent Variables

- Intake of total dairy, specific dairy groups (i.e. lowfat, high-fat, fermented) and dairy products (i.e. cheese, yogurt).
- Assessed using a semiquantitative FFQ containing 178 foods and beverages

Control Variables

- Energy
- Age
- Sex
- Socioeconomic status
- BMI
- Smoking
- Alcohol use
- Dietary intakes

Description of Actual Data Sample:

Initial N: 23,105 men and women

Attrition (final N): 21,553 men and women. Risk of hypertension examined in 3,454 after 5 years.

Age: Aged 20–65 years

Ethnicity: not reported

Other relevant demographics:

Anthropometrics

Location: Amsterdam, Doetinchem, and Maastricht

Summary of Results:

Key Findings

- Participants had a median intake of 344 g/d (~2.3 servings) for total dairy and 174 g/d (~1.2 servings) for low-fat dairy
- Intake of total dairy, specific dairy groups (low-fat, high-fat, fermented) and dairy products (i.e. cheese, yogurt) were not consistently related to BP.
- Of 3454 participants who were followed, 713 developed hypertension. The risk of hypertension tended to be inversely related to low-fat dairy intake, with multivariate OR (95% CI) of 1.00, 0.78 (0.61, 1.00), 0.81 (0.63, 1.03), and 0.82 (0.64, 1.06); consecutive quartiles, P for trend = 0.24.
- Mean BP was 120.1 ±15.7 mm Hg systolic and 76.1 ± 10.4 mm Hg diastolic and 15% of the population had elevated BP (i.e. 140/90 mm Hg).

Other Findings

- Dairy intake was associated with fruit intake (positively), coffee intake (inversely), and nonsmoking. In the lowest dairy category, which included more men, intakes of total energy, meat, bread, and total and saturated fat were higher than in other categories.
- The median energy-adjusted total dairy intake of the study population was 344 g/d, ranging from 110 g/d (i.e. <1 serving/d) in the lowest quintile to 765 g/d (i.e. >5 servings/d) in the highest quintile.
- The Spearman correlation coefficient was 0.91 ($P < 0.0001$) for the relation between total dairy and low-fat dairy and 0.41 ($P< 0.0001$) for the relation between low-fat and high-fat dairy.
- Subgroup analyses showed that the association between lowfat dairy and BP did not vary among strata of age, sex, BMI, or BP.
- The relation between low-fat dairy and BP continuously in the total cohort, the fully adjusted β (95% CI) per 50-g increase was 0.05 mm Hg (0.02, 0.09) for systolic BP and 20.04 mm Hg (20.06, 20.02) for diastolic BP was observed.
- In the subgroup (n = 4310) with a low habitual intake of dairy, these ß were 0.19 mm Hg (20.13, 0.50) and 20.09 mm Hg (20.30, 0.12) per 50 g, respectively.
- The subcohort that participated in the follow-up round was 49.5 6 9.6 y and comprised 45% men. BP in these participants increased by 5.7 6 12.7 mm Hg systolic and 3.1 6 9.6 mm Hg diastolic during a median follow-up period of 5 y and 713 (20.6%) new cases of hypertension were identified.

- Total dairy, lowfat dairy, and high-fat dairy were not significantly associated with risk of hypertension (P-trend 0.60, 0.24, and 0.11, respectively).
- After including physical activity in the multivariate model (n =2768), OR (95% CI) in the consecutive quartiles of low-fat dairy were 1.00, 0.83 (0.63, 1.10), 0.81 (0.61, 1.07), and 0.85 (0.64, 1.13), respectively (P-trend = 0.36).
- The association between low-fat dairy and hypertension risk did not vary by sex or age.
- After stratification by BMI (<25 vs. >25 kg/m^2), OR in the 2nd to the 4th quartiles of low-fat dairy intake were 0.95 (0.68, 1.32), 0.97 (0.70, 1.36), and 0.86 (0.61, 1.21; P-trend = 0.42) for participants who were overweight and 0.60 (0.42, 0.87), 0.63 (0.43, 0.91), and 0.76 (0.52, 1.11; P-trend = 0.34), respectively, for participants who were not overweight.

Author Conclusion:

Our findings suggest that dairy intake has little effect on population blood pressure in a generally healthy population of young and middle-aged Dutch adults. We found some evidence for a beneficial effect of low-fat dairy on risk of hypertension, although not significant, which needs to be confirmed in other population-based cohort studies.

Reviewer Comments:

Large original sample size of 21,553 subjects. Dietary intake only assessed at baseline, follow-up in 3454 participants.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes

1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A

4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes

7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes